Small Business Innovation Research/Small Business Tech Transfer

Advancing Hyperspectral Imaging through Integrated Compressive Sensing / Inpainting via Machine Learning, Phase I

Completed Technology Project (2018 - 2019)

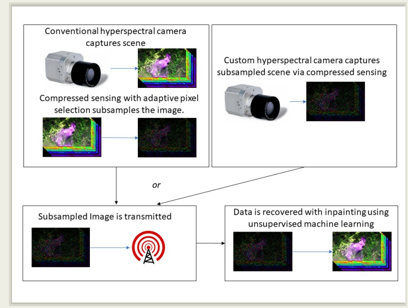
Project Introduction

We propose to use advanced algorithms for compressive sensing (CS) using inpainting which utilize machine learning to improve the capability of existing or novel hyperspectral imaging (HSI) systems. These approaches will allow for an order of magnitude improvement in the frame acquisition speed of existing detectors at a high compression ratio with no loss of resolution, while at the same time permitting them to overcome object obscuration and radiation damage phenomena in excess of existing technologies in this area. To accomplish these goals we propose to develop new hyperspectral sensors that intentionally omit pixels that will be recovered using model based compressive sensing. This provides the ability to selectively acquire a small number of pixels in an existing imaging array to form the complete image with no loss of image resolution or fidelity (or the ability to select an even smaller number with an acceptable loss of resolution). In addition, the algorithms that will be developed can adapt to the form of key image types using machine learning, so that the number of pixels can be reduced further, or that the pixels used for the image can be adaptively changed to avoid obscuration/damaged pixels. This type of imaging system has significant benefits for imaging/detection across a whole range of NASA programs and missions for recovery of damaged equipment or scenes, image enhancement, data compression or using novel designs with reduced pixel densities. This imaging approach will also automatically compress all images obtained by the level of sub-sampling used to form the image, reducing transmission and storage costs significantly, even without using additional lossless data compression before transmission.

Anticipated Benefits

This technology can be applied to both existing hyperspectral imaging systems and those being developed. The approach can be applied to both division of time and division of space systems, maintaining resolution while reducing capture time and noise. Additional applications are available in robust data compression for storage and transmission over long distances. This approach also provides fault tolerance, system recovery and image enhancement for fielded imagers with lost pixels.

Commercialization will come in two forms: enhancement of existing technologies which can leverage CS, and through selling custom-made imaging systems as build in functionality. Hyperspectral imaging systems are used in many applications including chemical and biological detection, manufacturing, environmental surveys of CO_2, pollution, and leakages. Also the improvement of existing infrared imaging systems by tolerating higher bad pixel densities reducing cost and improving performance.



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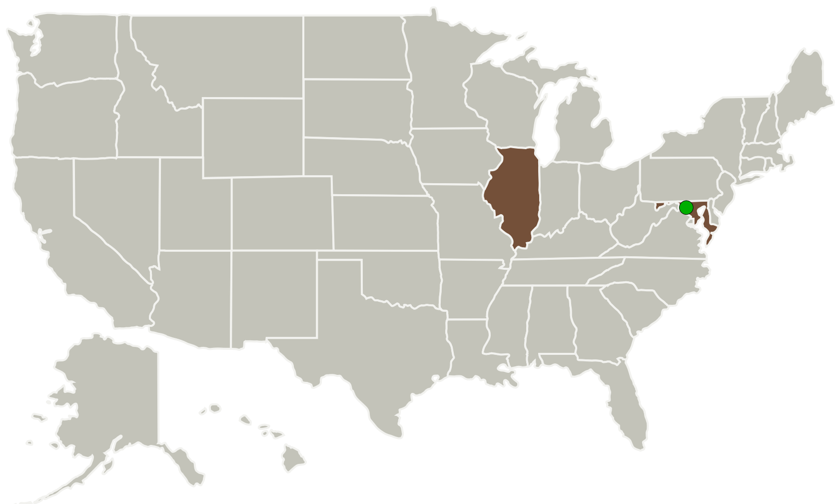
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Sivananthan Laboratories, Inc.	Lead Organization	Industry Minority-Owned Business	Bolingbrook, Illinois
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Illinois	Maryland

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:
- Final Summary Chart*(https://techport.nasa.gov/file/140917)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Sivananthan Laboratories, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Christopher Buurma

Co-Investigator:

Christopher Buurma

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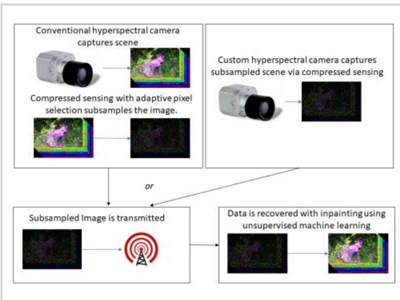
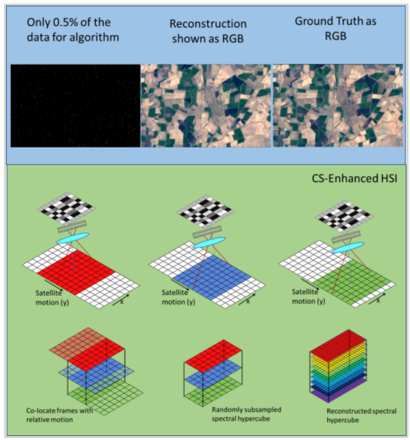
Images



Briefing Chart Image
Advancing Hyperspectral Imaging through Integrated Compressive Sensing / Inpainting via Machine Learning, Phase I
(https://techport.nasa.gov/image/137141)



Final Summary Chart Image
Advancing Hyperspectral Imaging through Integrated Compressive Sensing / Inpainting via Machine Learning, Phase I
(https://techport.nasa.gov/image/130455)

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**

1 2 3 4 5 6 7 8 9

Applied Research | Development | Demo & Test

Technology Areas

Primary:

- TX08 Sensors and Instruments
  └ TX08.1 Remote Sensing Instruments/Sensors
    └ TX08.1.1 Detectors and Focal Planes

Target Destinations

Earth, Others Inside the Solar System, Foundational Knowledge